HYDROLOGICAL PARAMETERS INFLUENCING THE PENETRATION OF ARABIAN GULF FISHES INTO THE SHATT AL ARAB RIVER, IRAQ

by

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ABSTRACT. – Sixteen Arabian Gulf fish species were recorded for the first time in the mid and upper region or Shatt Al-Arab river, Basrah, Iraq. Most of them are pelagic species, widely distributed in the Arabian Gulf and even in the different seas. They are obviously adapted to rather various environmental conditions. The changing in the chemical, physical and biological characters of Shatt Al-Arab river during the Iraqi-Iranian war may have facilitated recent immigration. A review to the environmental characters of both the Arabian Gulf and Shatt Al-Arab river are given.

RÉSUMÉ. – Seize espèces de poissons du Golfe Persique ont été signalés pour la première fois dans les zones moyenne et supérieure de la rivière Shatt Al-Arab, Basrah, Irak. La plupart sont des espèces pélagiques, largement répandues dans le Golfe et même dans d'autres mers. Ces poissons sont évidemment adaptés à des conditions écologiques variées. Les changements des caractéristiques chimiques, physiques et biologiques de la rivière Shatt Al-Arab au cours de la guerre irako-iranienne peuvent avoir facilité cette récente immigration. Une revue des caractères hydrologiques du Golfe et du Shatt Al-Arab est donnée.

Key-words : Iraq, Arabian Gulf, Shatt Al-Arab river, Migration, Hydrology, Marine fishes.

The two markedly different zoogeographical areas : the subtropical Arabian Gulf which is connected with the north western Indian Ocean and the Shatt Al-Arab river which is connected with the freshwater system of the old Mesopotamia, were joined together a long time ago during the geological eras (Purser, 1973). In order to pass between these two areas organisms must be able to bridge the difference in adaptive requirements, and also withstand the extreme conditions in the Shatt Al-Arab estuary itself. It is therefore highly interesting that at least sixteen Arabian Gulf species of fishes have succeeded in reaching the northern part of the Shatt Al-Arab river, and, in recent years, some have developed into commercially important populations (*Hilsa ilisha* and *Nematalosa nasus*).

It is well known that the clear understanding of the taxonomic situations is essential for zoogeographical purposes. Unfortunately, we still lack accurate information about the relationships between many fishes found in the Arabian Gulf and Shatt Al-Arab river. So, at the present time we can only give some preliminary

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data and suggest what future research appear to be desirable. The purpose of the present study is to record the presence of marine fish species in Shatt Al-Arab river.

ENVIRONMENTAL CHARACTERS OF SHATT AL-ARAB RIVER :

Shatt al-Arab river formed during the last 5000 years as a result of the junction of Euphrates and Tigris rivers (Rzoska, 1980). The total length of this water way is about 200 km, the width varies from 400 to 1500 m, its depth from 7,5 to 12,5 m. Along the river, some shallow areas have to be dredged because of the commercial importance of the channel. This is necessary because of the abundant sediment load brought down from the Iranian plateau by the Karun river, which enters the Shatt near the Iranian port of Abadan, south of Basrah. Water level in Shatt Al-Arab is under the influence of sea tides, from 3 m near the mouth to 0.5 at Basrah; the influence of the tide is felt about 140 km inland with a penetration of marine organisms upstream (Rzoska, 1980). The velocity of water flow during the low and high tide varies between medium and fast. This water movement depends mainly on the water level in the Shatt : during the flood season (January to June), the water moves very fast and its velocity reaches 4 knots (P.G.P., 1967). On contrast, during the dry season (July to December), the water movement drops down to 2-3 knots.

Shatt Al-Arab is characterized by a small (< 1° C) or absent vertical stratification of temperature (April 1974 : Saad & Kell, 1975, Kell & Saad, 1975 and Februray 1978 : Maulood *et al.*, 1979). From these two periods, we can envisage a range of 25.0-25.3° and 15.5-17.0° C. Arndt & Al-Saadi (1975) measured the seasonal extremes at Basrah and they found that in January the temperature ranges from14-15° C and 32° C in August. No marked thermic stratification was noticed even at the higher seasonal temperature (Mohammed 1965; Arndt & Al-Saadi, 1975).

Saad & Kell (1975) published data on transparency in Shatt Al-Arab using a Secchi disc. These values range from 50-70 cm during the flood period in April 1974. Although these are low compared with many rivers, they still suggest a considerable shedding of sediment from more turbid waters upsteam. Similar values were recorded along the longitudinal section of the Shatt by Saad & Kell (1975) just before and just after the arrival of flood water, and in February 1978 (Maulood *et al.*, 1979). Values greater than 1m are known seasonally from Shatt Al-Arab at Basrah; (Arndt & Al-Saadi, 1975; Saad, 1978a); these indicate minima in the sediment load during low flows.

High levels of salinity are prevailed in the Shatt, not only due to the accumulated salt flux from the north, but also due to a marine influence that extends a varying distance up the estuary. The distance is naturally reduced during phases of high river flow (Al-Sahaf, 1975). Various authors (e.g. Al-Sahaf, 1967; Arndt & Al-Saadi, 1975; Maulood *et al.* 1979) have described the longitudinal distribution of salinity or conductivity. In the upper reaches, the conductivity is typically about

1000 μs/cm at 25° C, followed by an increase downstream at a distance from the sea which varies, for hydrological reasons. The Karun river may produce an important increase in the conductivity (Al-Sahaf, 1975).

Almost all the ionic content is contributed by four cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) and four anions (HCO_3^-, CO_3^{2-}, Cl^-, SO_4^{2-}) (Talling, 1980). In the Shatt, the ions Na^+ and Cl^- are dominant, a trend that is naturally enhanced in the lower estuary region. Estimations of Cl^- concentration (chlorosity) have been employed by several authors (Mohammed, 1975; Saad & Kell, 1975); Kell & Saad, 1975; Saad, 1978 a,b; Maulood *et al.*, 1979) as a test to the mixture of fresh- with seawater. As an effect on the salinity of the Arabian Gulf, Emery (1956) has noted that Shatt Al-Arab has a great effect on the salinity of the Gulf during the flood season and Saad (1978a) has shown that the effect of the Shatt Al-Arab water extends five kilometers inside the Gulf. During the flood season Brewer *et al.* (1978) have found that the effect of Shatt Al-Arab water extends to the Kuwait Bay.

The oxygen concentrations in surface water were usually 50 per cent or more of saturation (Mohammed 1975; Kell & Saad, 1975; Maulood *et al.*, 1979). Differences with depth were generally minor.

The values of PO_4 ranges between 0.4 and 2.2 mg/l in Shatt Al-Arab (Al-Sahaf, 1975). A conspicious decline in Si from fresh to sea water has been noted by Maulood *et al.*, (1979) this being a common situation in estuaries.

An almost consecutive study of the phytoplankton of the Shatt Al-Arab near Basrah was made by Huq *et al.*, (1978) (see also Al-Saadi *et al.*, 1979). Their counts indicated some decline of total density in mid-winter (December) as well as during flood water in April. In the Shatt one would expect a meeting of marine and freshwater elements with some correlations to the longitudinal gradient in salinity and chloride contents. This is confirmed by the studies of Kell & Saad (1975), Maulood *et al.*, (1979) and Hinton & Maulood (1979). The former list 226 species, including 95 of marine origin whose proportions increased downstream. Diatoms were again generally preponderant; their silica remains contribute to the sediments (Saad, 1975). Maulood *et al.*, (1979), found a large increase of phytoplankton density at their seaward station.

ENVIRONMENTAL CHARACTERS OF THE ARABIAN GULF :

The Arabian Gulf lies between latitude 24° and 30°30'N, with its extreme width between longitude 48°45' and 57°E. It is a marginal sea measuring 1000 km in length and 200-300 km in width and thus, covers an area of about 239,000 km^2. With an average depth of about 35 m, it is calculated to contain a total volume of water of about 850 x 10^{10} m^3 (Anbar, 1974).

The Arabian Gulf penetrates from the Indian Ocean near its entrance at the strait of Hormuz, which is a narrow bend about 60 km wide with numerous obstruction (Purser and Seibold, 1[illegible]). The north western end of the Gulf terminates in the Shatt Al-Arab delta.

The bottom of the Arabian Gulf basin is somewhat asymetrical sloping gently from the Arabian side, but dropping sharply towards the Iranian shore lines, where it attains its maximum depth. Again the Gulf bottom slopes gradually from north to south where it reaches a depth of about 180 m near the strait of Hormuz. From there, a sudden drop to the Gulf of Oman is clearly noticeable (200-3000 m depth) (Anbar, 1974). The average depth of the water in the Gulf is about 35 m, but along its axis this increases to 60 m and the maximum depth found, so far, is 120-150 m near the Iranian Coast.

According to Emery (1956), 52 % of the Arabian Gulf is covered by mud, 39.7 % sand, 5.5 % by mud and sand, 1.8 % is rocky, 0.6 % is covered by coral growth and 0.3 % by gravels.

Regional tidal currents are oriented approximately parallel to the axis of the Gulf. They attain velocities of *ca* 50 cm per second at about 0-4 m above the bottom (Hartman *et al.*, 1971) influencing sediment textures even in the deepest part of the Gulf.

Waves and surface currents, are driven mainly southeasterly by the action of northwesterly wind. Most of the Arabian Coast and adjacent offshore environments are exposed to those winds. The waves and surface currents produced by « Shamal » winds, together with tidal currents, tend to homogenise the surface waters to a depth of *ca* 30 m. Because the « Shamal » winds blow down the axis of the Gulf from the NW, wave base is almost certainly at its minimum along the sheltered shores of the Shatt Al-Arab, at the NW end of the Gulf (Purser, 1973).

Emery (1956) demonstrated the presence of two kinds of water-currents based on the distribution of temperature, salinity and water density. The first is a broad surface current setting into the Gulf through the strait of Hormuz to replace losses by evaporation. Another more minor surface current into the Gulf consists of fresh-water from the delta.

The higher rainfall areas of Zagros and Tauros mountains supply the Tigris, Euphrates and Karun rivers which combine at the Shatt Al-Arab, giving a very considerable water influx (Purser, 1973). Emery (1956) quoted that Schott (1908) explained the condition of salinity during winter as being greater than in summer, due to the variation in flow of freshwater through the Shatt. Schott (1908) stated that the flow is least from September to November and that, in December, local seasonal rainfall causes an increase and the discharge continues rather high through January, February, and March. In April, the melting snow of the Armenian mountains causes another increase that finally reaches a higher point in May and June. In July, the river discharge falls again.

Wyrtki (1971) has compiled all relevant data from the international Indian Ocean Expedition (1971) in an Atlas. This atlas underlines the basic hydrographic parameters. The seasonal surface temperature variations may be as high as 17°C, from 18°C in March to 35°C in August and the salinity varies from almost 42°/oo in the inner part of the Gulf in August to 37°/oo in the transition area of the straits of Hormuz.

The entire area of the Gulf is shallow, resulting in a much more developed interaction and mixing of deeper water and surface waters, the total amount of deeper water acting as a nutrient trap.

Grasshoff *et al.* (1976) discussed the seasonal fluctuation and distribution of salinity. He revealed the probability that the salinity is highly variable and strongly dependant on the prevailing wind conditions. Another possible explanation could be the long and short term fluctuations in the water discharge of Euphrates and Tigris.

Hartmann *et al.* (1971) give a total annual discharge of 5 km^3/year only. Such low annual discharge in freshwater could well cause an increase of the surface salinity of 2°/oo in an area of 1000 km^2 (Koske, 1972).

It is possible that the stratification in the strait of Hormuz is not limited to a double layer. Water from just below the thermocline from the Gulf of Oman may also penetrate into the Arabian Gulf. This water is rather rich in nutrients. The penetration of nutrients-rich water into the Gulf and its further distribution and mixing are a function of the stability of the water column, the system of currents and eddies and the bottom topography (Seibold *et al.*, 1969, 1970). It could be that silicate is the limiting nutrient in the Gulf.

Grassholf *et al.* (1976) concluded that considerable productivity exists, being highly variable and closely limited to the nutrient distribution.

SHATT AL-ARAB & ARABIAN GULF ICHTHYOFAUNA :

Although some works have been published on the Ichthyofauna of Iraq (Mahdi, 1962; Kalaf, 1961; Al-Nasiri & Hoda, 1976), no separate work has been done on the Ichthyofauna of Shatt Al-Arab.

On the other hand the fish fauna of the Arabian Gulf had a better chance among the scientific publications. Although rich in number of species, due to a combination of salinity and temperature extremes, siltations from Shatt Al-Arab and wind-blown dust, and shallowness, the Arabian Gulf contains only a portion of the even richer fauna of the Indian Ocean. Intertidal zones may be especially poor in species due to exposure to extreme heat and consequent dessication, although especially adapted animals such as mudskipper fishes may make use of such habitats where there is soft mud and, by providing flooded burrows, may actually bring about the use of the area by more life forms.

The work of Regan (1905) can be considered as the first systematic work on the fishes of the Arabian Gulf, he listed 57 species. Later in 1916 and 1917 Lane described several game fishes from different parts of the Gulf.

Later on Berg (1918, 1931), Kennedy (1937), Hora and Misra (1943), Trewavas (1955), Menon (1960), Ladiges (1960), Kalaf (1961), Beckman (1962), Mahdi (1962), Ladiges (1964), Banarescu and Nalbant (1964), Mazhar (1966), Mahdi (1971), and White & Barwani (1971) made important constributions to the ichthyofauna of the Gulf. Blegvad's investigations in 1944 however, were more significant. He described nearly 215 species. Other contributions in this field during recent years were made by Mahdi & George (1969) who listed 340 species of fishes from freshwaters of Iraq and the Arabian Gulf; also Kuronuma and Abe (1972) conducted a survey in the coastal waters of Kuwait and the Arabian Gulf where they described 131 species. Further additionsto the fish fauna collection from the Gulf were made by Al-Daham (1974, 1975, 1976, 1977, 1979).

The above literature review indicates that a fairly good information is available on fish fauna of the Gulf, but works are scattered and therefore it is difficult to locate them easily.

Annoted list of the Arabian Gulf species in Shatt Al-Arab :

1. CLUPEIDAE
   Ilisha filigera (Valenciennes, 1847)
   Ilisha megaloptera (Swainson, 1839)
   (Al-Hassan, 1983 : 120, Shatt Al-Arab river at Hamdan village).
2. DOROSOMATIDAE
   Nematalosa nasus (Bloch, 1795)
   (Al-Hassan, 1983 : 130, Shatt Al-Arab river at Qarmat Ali).
3. ENGRAULIDAE
   Thryssa malabarica (Bloch, 1795)
   (Al-Hassan, 1983 : 200, Shatt Al-Arab river at Hamdan village).
4. CHIROCENTRIDAE
   Chirocentrus nudus (Swainson, 1839)
   (Al-Hassan, 1983 : 10, Shatt Al-Arab river at Hamdan village).
5. SILLAGINIDAE
   Sillago sihama Forsskal, 1775)
   (Al-Hassan, 1983 : 10, Shat Al-Arab river at Hamdan village).
6. CARANGIDAE
   Alepes djedaba (Forsskal, 1775)
   (Al-Hassan, 1983 : 10, Shatt Al-Arab river at Hamdan village).
7. SPARIDAE
   Sparidentex hasta (Valenciennes, 1830)
   (Al-Hassan, 1983 : 100, Shatt Al-Arab river at Abu Al-Khaseeb).
   Acanthopagrus berda Forsskal, 1775)
   (Al-Hassan, 1983 : 100, Shatt Al-Arab river at Abu Al-Khaseeb).
8. SCIAENIDAE
   Johnius carutta (Bloch, 1793)
   (Al-Hassan, 1983 : 10, Shatt Al-Arab river at Hamdan village).
9. SCATOPHAGIDAE
   Scatophagus argus (Linnaeus, 1766)
   (Al-Hassan, 1983 : 50, Shatt Al-Arab river at Mehaigran village).
10. MUGILIDAE
    Liza macrolepis (Smith, 1849)
    (Al-Hassan, 1983 : 100, Shatt Al-Arab river at Hamdan village).
11. POLYNEMIDAE
    Eleutheronema tetradactylum (Shaw, 1804)

(Al-Hassan, 1983 : 50, Shatt Al-Arab river at Hamdan village).

12. SOLEIDAE
    Synaptura orientalis (Bloch & Schneider, 1801)
    (Al-Hassan, 1983 : 20, Shatt Al-Arab river at Hamdan village).
13. CYNOGLOSSIDAE
    Cynoglossus macrolepidotus Bleeker, 1851)
    Cynoglossus arel (Schneider, 1801)
    (Al-Hassan, 1983 : 20, Shatt Al-Arab river at Hamdan village).

CONCLUSION

It is possible at this moment to put forward a number of reasons that may explain the northward movement of some fish species from the Arabian Gulf. And due to the great lack of ecological information for fishes both found in Shatt Al-Arab river and the Arabian Gulf, the following reasons are only probabilities :

1. The species under consideration may resist to low temperature and low salinity.
2. Due to the hault of navigation in Shatt Al-Arab area as a result of the Iraqi-Iranian war, fishes may be attracted to more northward area to find unexploited ecological niches to live in.
3. There is a great probability that the level of pollution in Shatt Al-Arab river drops down during the years of the war and this may help some species of fishes to inhabit this water way.

In conclusion, it may be emphasised that this picture, simple and probably rough, shows the inadequacy of our knowledge of the relationships between Shatt Al-Arab and the Arabian Gulf ichthyofauna. A close co-operation between Iraqian and Gulf ichthyologists is absolutely necessary for a better understanding of the problems. As in many other fields of modern science, there are problems that cannot be solved by an individual, even if very competent. It is hoped that this account will stimulate further research in this field to solve many of the biological problems.

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